GOES R Series Meteorological Satellites Proposed Spectrum Usage

International EESS Wideband Downlink Workshop
Orlando, Florida
March 25, 2003

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Introduction

- GOES Background Information
- GOES R Satellite Spectrum Requirements
- An Example of How These Requirements Could Be Meet, and Comment Solicitation
  - This Presentation is One of Several Possibilities NOAA is Investigating
  - It is Based on Work Performed By NOAA, Aerospace, and Mitretek

GOES Satellite Functions

- Acquire Imaging and Sounding Sensor Data
- Monitor Solar and Space Environment
- Transmit Raw Sensor Data to CDA Stations (SD)
- Rebroadcast Level-1B Data to Primary Users (GRB)
- Collect Data from Air/Water/Land Based DCPs
- Relay Distress Signals (Search and Rescue)
- Relay Meteorological Data to Many Large & Small Distributed Users (Wefax/LRIT, EMWIN, DCPR)
- Support Spacecraft Health and Safety
  - Command and Telemetry

GOES Constellation

- Satellite Locations:
  - Operational: 75º West and 135º West Longitude
  - Test/Storage: 105º West Longitude
  - 135º West May be Changed to about 137º West for Coordination with DSCS
- Ground Station Locations:
  - Wallops VA: 37.95º N, 75.46º W
  - Fairbanks AK: 64.97º N, 147.51º W
  - GSFC MD: 39.00º N, 76.84º W

GOES R Current RF Status

- Required Data Rates are Uncertain
  - One or two satellites per slot
  - Instrument performance predictions vary
  - Need to find an allocation and fit GOES signals to it
- Major RF Variables that Impact Sharing
  - Modulation type: QPSK, 8PSK, 16QAM
  - SRRC pulse filtering: $0.35 < \alpha < 1.0$
  - FEC code type and rate: 3/4 to 15/16
  - Spacecraft antenna size: 0.2 to 1.0 meter
- GOES R Launch is Scheduled for 2012

Why GOES Needs to Use X-band

- Data from GOES Satellites is Most Needed During Bad Weather Conditions When Short Term Predictions and "Now-Casting" from Imager and Sounder Data are Critical
- DCS Relay of Ground-Truth Measurements Used to Calibrate Radar and Satellite Values
- New Data Rates Cannot Fit in Current L-band
- X-band is Only Other Allocation with Tolerable Levels of Rain Attenuation
  - 18.2 GHz is next available band

Example Raw Data Downlink

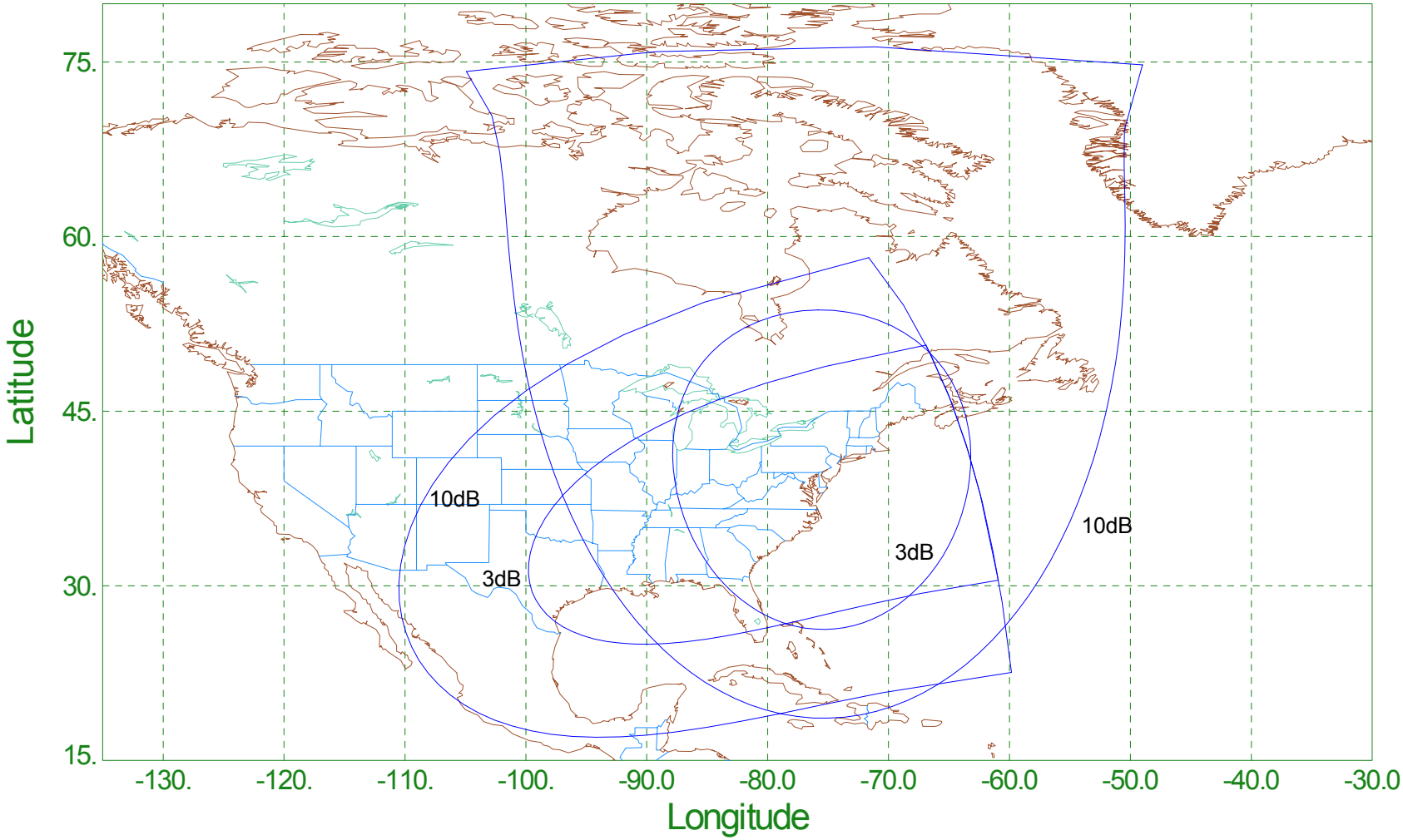
- Frequency Band: 8215 – 8400 MHz
- Data Rate: 90 – 150 Mbps
- Modulation: OQPSK
- Filtering: SRRC with α = .35 at -30 dB sideband level
- FEC Coding: Turbo Product Code at rate 15/16 or equal
- Bandwidth: 64.8 – 108.0 MHz
- Required EIRP: 71 dBmi for 90 Mbps

Example Antenna Parameters

- Frequency Range: 7190 to 8400 MHz
- Polarization: RHCP
- Ground Antenna: 16.4 meter
  - G = 60 dBi
  - T_S = 400ºK
- Satellite Antenna: 0.75 meter
  - Transmit Gain = 34 dBi
  - Receive G/T = 4.3 dB/K

0.75-meter Parabolic Dish Antenna Patterns from 75W, 135W

3dB down = 1.6 deg half-angle, 10dB down = 2.8 deg half-angle
Target: Wallops, VA (37.93N, 75.48W)



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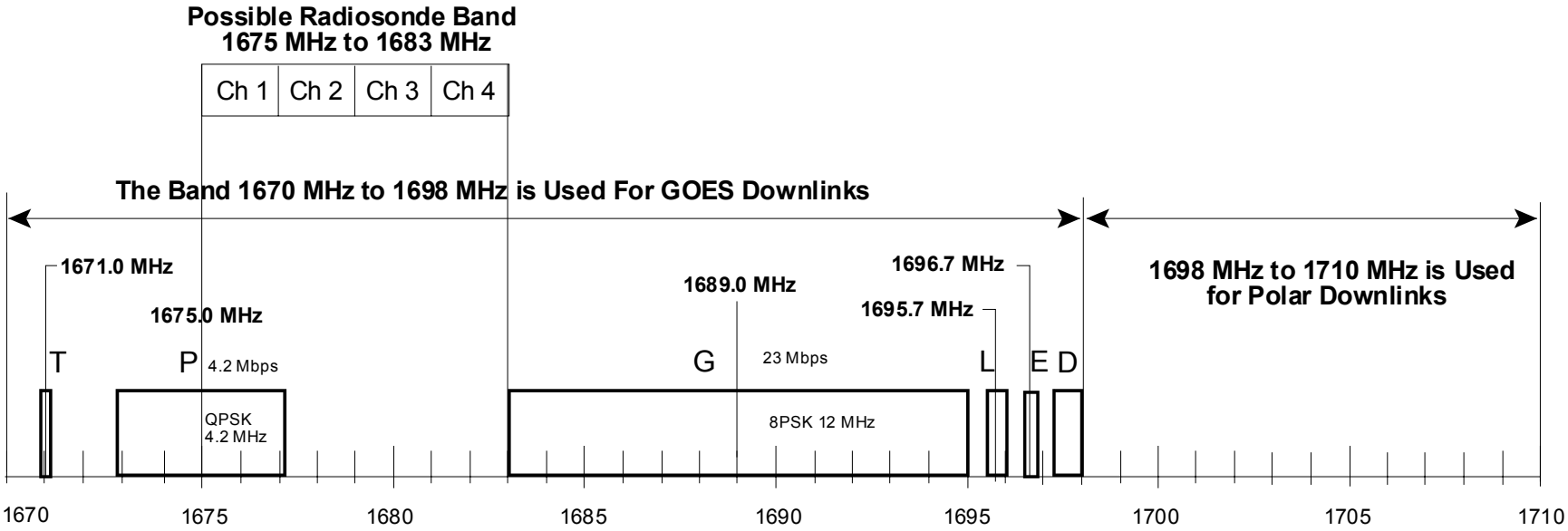
Other GOES-R Links

- Uplinks at S-band: LRIT, EMWIN, and Command Could Move to X-band
- Downlinks at L-band: GRB, LRIT, EMWIN, DCPR, Telemetry, and (possibly) PDR
- All Require Full Earth Coverage (to 5º El)
- All Similar to Current GOES Links but Increased Data Rates Assumed
- GOES R Also Has Other Links That Do Not Impact X-band

Example GOES-R L-band Links



LEGEND:
G - GRB P = PDR L = LRIT E = EMWIN T = Telemetry D = DCPR

Range of GRB Uplinks

- Frequency Band: 7190 – 7235 MHz* or 8175 – 8215 MHz
- Data Rate: 10 – 25 Mbps
- Modulation: OQPSK/8PSK/16QAM
- Filtering: SRRC with α = .35 at -30 dB sideband level
- FEC Coding: Turbo Product Code at rate 3/4 – 15/16 or equal
- Constraint: L-band Downlink Must be 12 MHz or 20 MHz max. if Radiosondes Share or Not

* NOAA is not currently authorized in this band

Example GRB Uplink

- Frequency: 7228 MHz
- Data Rate: 23 Mbps
- Modulation: 8PSK
- Filtering: SRRC α = .35 at -30 dB
- Bandwidth: 12 MHz
- FEC Coding: TPC rate 15/16 or equal
- S/C G/T: 4.3 dB/K
- Uplink EIRP: 110 dBmi

Summary GOES X-band Needs

- 1 Downlink to the CDA Stations for Data Generated on the Satellite
- 1 Uplink from the CDA Stations for GRB Link to Users (Downlink at L-band)
- Full Time Usage at 75 and 135/137 West
- Other GOES Up and Down Links Are Not Expected to Effect X-band or Other EESS Allocations

Acronyms

CDA	Command and Data Acquisition
DCPR	Data Collection Platform Report
DCS	Data Collection System
DOD	Department of Defense
DSCS	Defense Satellite Communication System
EMWIN	Emergency Managers Weather Information Network
GOES	Geostationary Operational Environmental Satellite
GRB	GOES Rebroadcast
GSFC	Goddard Space Flight Center
LRIT	Low Rate Information Transmission
NOAA	National Oceanic and Atmospheric Administration
PDR	Processed Data Relay
SD	Sensor Data
SRRC	Square Root Raised Cosine
Wefax	Weather Facsimile